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The Miami Conservancy Bulletin

APRIL, 1921

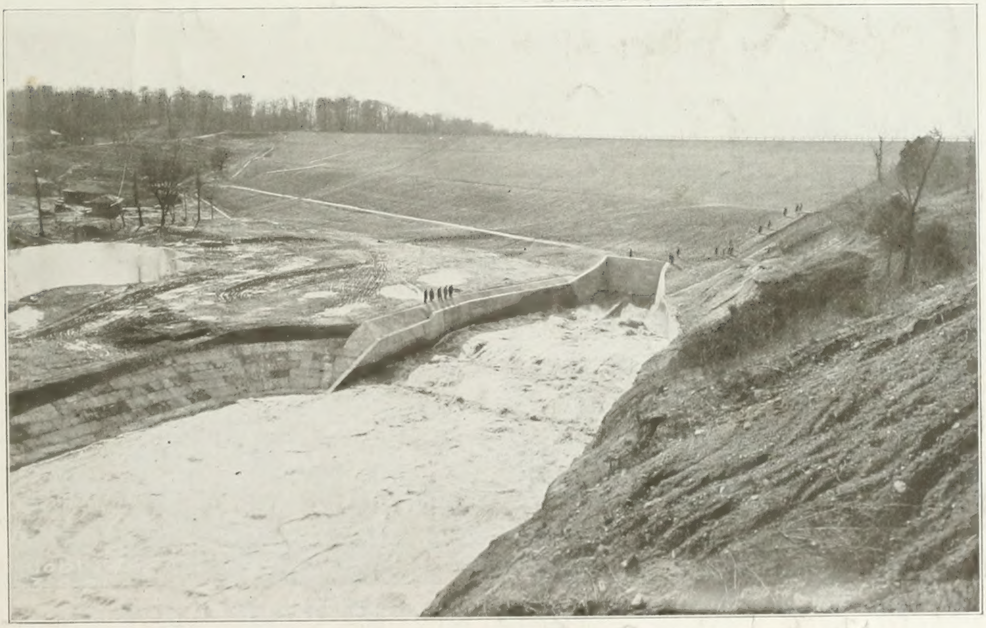

FIG. 287—GERMANTOWN DAM, COMPLETED, AT WORK CHECKING FLOOD, MARCH 28, 1921

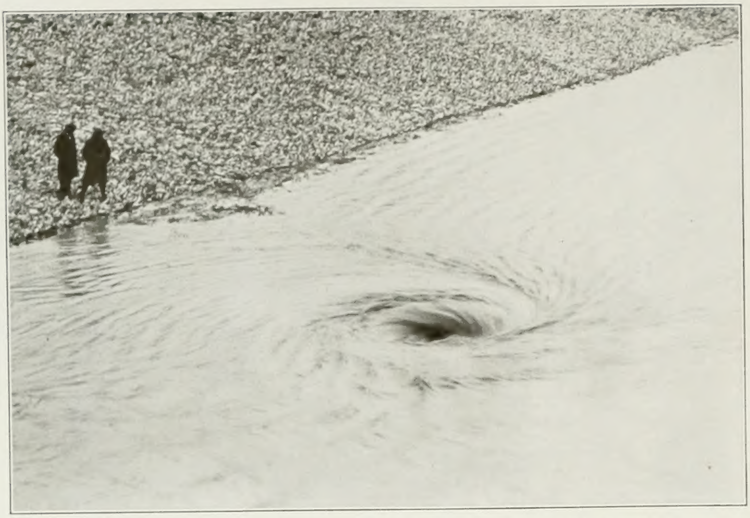

FIG. 288—"THE EYE OF THE STORM," GERMANTOWN DAM, MARCH 28, 1921

Compare Fig. 303, where the same vortex is shown just beyond the two men at the right. It was 32½ feet above the entrance to the dam conduits, and is formed by the motion of the water in the same way that the vortex is formed in a lavatory basin when the outlet plug is drawn. Boards, branches and other floating debris were sucked down this vortex into the conduits and thrown out at the exit on the other side of the dam. (See Fig. 292). As the water in the lake behind the dam grows deeper with higher floods, this vortex will be drowned out.

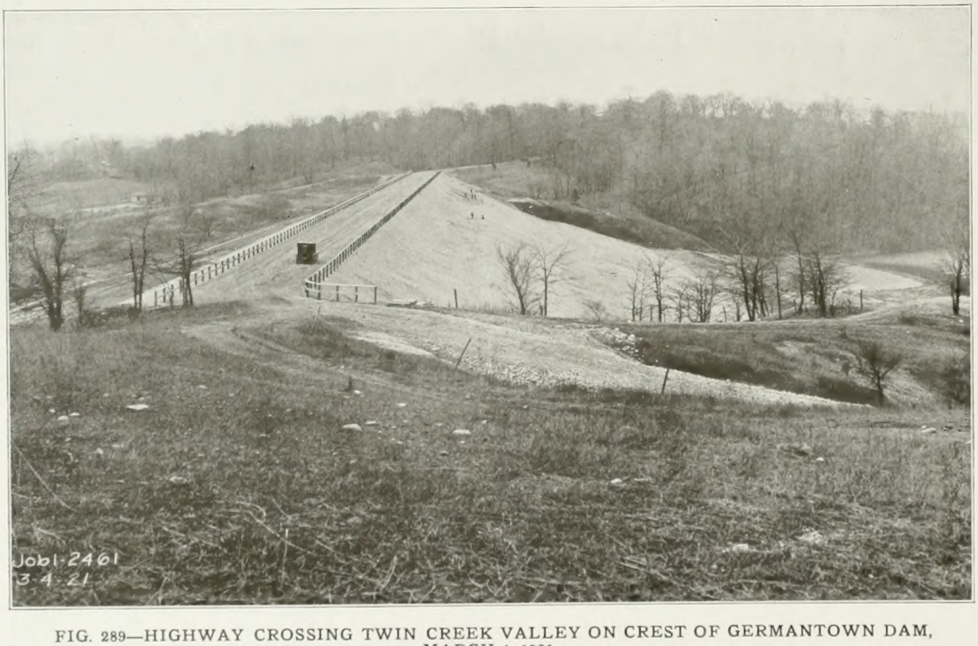

FIG. 289—HIGHWAY CROSSING TWIN CREEK VALLEY ON CREST OF GERMANTOWN DAM, MARCH 4, 1921.

This highway connects the Twin Creek valley roads on the north and south sides of the creek. It is 109 feet above the old creek bed. The slope at the right is the upstream dam slope. The conduits carrying the water seen in Fig. 287 pass under the dam a little beyond the automobile and 107 feet below it (measured to the conduit floor). The dam crest is 1,210 feet long. The road width is 30 feet.

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Index

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G. L. TEEPLE, Assistant Engineer, EDITOR.

The Successful Test of the Germantown Dam

The leading interest in the present Bulletin is in the account of the successful test of the Germantown dam in the storm of March 28. This being the first trial of a Conservancy dam in an entirely finished condition, the result is of unusual importance. The storm was a small one, the maximum rainfall on the Twin Creek watershed, which the Germantown dam stand guard against, being 2.22 inches; but as pointed out in the leading article, small storms furnish a test of the working of the dam and retarding basin system out of all proportion to their size. The quantity of water trapped behind the Germantown dam by the storm of March 28 was only one-twelfth of what would be trapped by such a storm as that of 1913; yet the depth of water behind the dam on March 28 was nearly one-half, and the amount of water discharged into the valley below was more than one-half of the corresponding quantities with a 1913 storm. This is due to the increased flatness of the upper slopes of the valley which forms the basin into which the water backs up behind the dam; the effect being a rapid rise of flood water in the basin with small rainfalls, in which the water only reaches the lower valley slopes, and a slower and slower rise with greater floods, as the water in the basin spreads out over the flatter and flatter upper slopes.

As to the effect of the dam on the flood level of March 28, measurements showed that it lowered the flood crest just below by 3¼ feet. They showed also that a storm as great as that of 1913 will not give a flood crest in the valley just below quite as high as the little storm of March 28 would have given had no dam been built.

The working of the concrete outlet basin, specially designed and built to receive and quench the destructive energy of the flood water as it is discharged from the dam conduits into the valley below, was another feature of the test which gave great satisfaction to the Conservancy engineers. The velocity in the conduits on March 28 was 29 feet per second—more than half that which would be given by a 1913 flood, and the basin handled it with ease. The velocity was reduced to 5½ feet in the valley below, and the destructive energy was reduced to less than 1/27 of its intensity in the conduits. The stability in position of the "hydraulic jump" under widely varying speeds of conduit flow, and the remarkable evenness of the flow through the jump under high speeds of discharge mentioned, with the complete quenching of undesirable back eddies, were very notable. Much attention was given to the design of the outlets in order to secure these desirable features, the problem presented by the high velocities of discharge of flood waters being regarded as one of the most formidable which the Conservancy engineers had to meet. The performance at Germantown on March 28, corroborating so fully as it did the expectations and calculations of the designers of the outlet, was especially gratifying.

Such a performance it was a pleasure to watch, and it is a pleasure to record. It furnishes another link in the strong chain of reassurance which the Conservancy work is forging, whereby the minds of the people of the Miami valley may be at peace in the

face of any flood which may befall. To the workers it furnishes additional stimulus to push forward the remaining links in the project until the full work is completed.

The Work of the Present Season May Bring the Miami Valley Practically Full Flood Protection

It needs to be emphasized, in connection with the successful test of the completed structure at the Germantown dam, that the Conservancy work of the present season will probably bring to the Miami Valley full flood protection. The work is so far ahead of schedule that its practical completion during the present season is not at all unlikely. The Germantown dam is done. Lockington dam will be finished during the summer; the dams at Huffman and Taylorsville, barring unforeseen mishaps, by the end of next winter. The dam at Englewood, the largest of all and therefore the latest to be done, will not be entirely completed, but the work is being pushed so rapidly and is so far ahead of schedule that by winter the embankment will be above the level which can be reached even by a 1913 flood. The conduits at Englewood are now in their temporary form, to act more efficiently as safety valves for flood water behind the dam during construction, but it is not unlikely that one of these may be brought to final form before another spring. Even as they are, with the embankment above 1913 flood level, and the other dams all finished, the water released into the valleys below will not be sufficient to work any material damage. With the present flood season practically at its close, the people of the Miami valley can look forward with high confidence to complete protection from flood.

New Application of the Acetylene Torch to Restoring Outworn Machine Parts

An original and ingenious application of the acetylene torch to the converting of an outworn steel shaft into one which is even better than new, has been lately perfected by Mr. Wm. McIntosh, Master Mechanic of the Conservancy shop. It produces what is in effect a new bronze bushing welded to the shaft and replacing the outworn surface. The old shaft is first turned in the lathe over the worn portion to a smaller diameter, "necking" it down thus about one-eighth inch. Bronze is then fused to the surface of the neck by the acetylene torch until the diameter is a little greater than it was originally. The fused new bronze surface of what was the neck is now, of course, rough. This surface is now turned down to its original diameter, making what is in effect a new shaft, but with a bronze bearing surface at the journal instead of a steel one.

This method has been successfully applied to heavy shafts like the 6-inch swing shafts of the large dragline excavators on the Conservancy work; also to dredge pump shafts, which in some designs are peculiarly liable to quick wear on account of the sifting of fine sand into the bearings from the material going through the pump. The same method has been successfully applied also to refacing the nut which takes the end thrust of the drum shaft on a dragline shaft, when the friction clutch is thrown in. Many other applications will suggest themselves to those interested. The method gives a very inexpensive replacement of a worn part, which in many cases—as in the swing shaft above noted—may have cost a good deal of money and would otherwise have to be thrown away.

Little Delay to Work by Flood of March 28

The effect of the storm of March 28 at Germantown is treated elsewhere in this issue. On the remainder of the work the storm did little damage and led to only insignificant delay. The rainfall varied over the valley from 0.94 at Greenville to 2.28 at Germantown dam. It produced a rise in the Miami at Main Street bridge, Dayton, to a maximum stage of 11.9. The maximum in April of last year was 16.2. At Lockington Loramie Creek rose 5 to 6 feet back of the dam, the water getting into the warehouse, but not to a depth sufficient to do any damage. There was no stoppage of work. At Taylorsville also there was no damage and no stoppage of the work. At Englewood the condition in the valley above the dam is shown in the picture on the back outside cover page. It created "some lake," but the damage was trifling. There was two days' delay to the work, the borrow pit being under the water in the picture referred to. The trestle across the Stillwater above the dam, which is on a 3 per cent grade, was just covered from end to end, but entirely undamaged, possibly in part because the main current was switched temporarily through the west borrow pit. The water rose 3 to 4 feet above the top of the entrance arch, to elevation 791, and 21 feet short of the "safety valve" formed by the temporary spillway. A modified "hydraulic jump" was formed at the outlet which was much like that at Germantown a year ago, the dam conduits at Englewood being still of double depth. There was a slight wash at one point in the borrow pit tracks. At Huffman the water rose a foot higher than in April of last year, but the flow was considerable slower, on account of the shift in the Mad River flow from the old diversion channel through the concrete outlet works. There was a drop of 3 feet in the water level through the outlet, with strong current, but no damage. The work was stopped for three shifts, due to the necessity of lifting the pump's motors above flood level. Through the cities there was a some delay to the channel improvement work, but no material damage.

Ohio Electric New Line Opens from Huffman to Fairfield

The relocated line of the Ohio Electric Railway between Huffman and Fairfield was put in operation on April 9. This is the portion of the new line running through the big rock cut at the south end of the Huffman dam, and thence northeastward along the border of the Huffman retarding basin on top of the inner levee. This levee is 35 feet above Mad River valley bottom, and together with the big cut (120 feet in height) makes this road a real "scenic line." The northern section of the Ohio Electric relocation, from Fairfield to Medway, is not yet built, the southern portion being the more important to get into operation to clear the way for the Huffman dam construction. Work on the uncompleted section will be begun at once, and is scheduled to be ready for operation about August 1.

Successful Test of the Completed Outlet Works at Germantown Dam

Solution of the Important Problem of Quenching the Destructive Energy of the Issuing Flood Water

The storms of March 9 and March 28 gave the first opportunity of seeing the "hydraulic jump" at a Conservancy dam outlet in full operation. In April of last year the jump was seen at two of the dams—Germantown and Lockington—but in both cases the conduits were in their temporary form, much enlarged in order to act as safety valves for flood water back of the dams during construction. The completion of the conduits in their final form at Germantown during the winter gave a chance this spring for a decisive test, the more so that the storm water of March 28 was sufficient—backing up behind the dam to a depth of 37 feet, and issuing at the outlet with a velocity of 29 feet per second—to furnish an excellent line on the operation of the jump under high floods.

The object of the peculiar design is to kill the destructive speed and energy of the flood waters as they issue into the valley below the dam. The problem is a very real one. At Germantown on March 28 a mass of water came plunging from the outlets every minute, equivalent to 195 freight cars of 100,000 pounds each, going nearly 20 miles an hour. With a storm like that of 1913, the mass issuing per minute would be equivalent to more than six 50-car freight trains, going at 37.5 miles an hour. The destructive effects of letting loose such powerful masses to plow up the creek bottom below, with possible undermining of the dam itself, can be readily imagined. The problem of the Conservancy engineers was to kill this destructive force. They did it by perfecting and adapting the "hydraulic jump." It was one of the most important problems connected with the project, and took a year of investigation, experimentation, repeated design, and repeated trial of the design by a working model, before the problem was fully solved.

The result at the Germantown dam, operating at an ordinary stage of water, is shown in Fig. 291. The conduits are seen to be twin tunnels of concrete, carrying Twin Creek beneath the dam (the downstream slope of the embankment being seen rising behind the outlet mouths). The water, issuing from the conduits, is seen to break a little below into a narrow sheet of foam, indicating the position of the "hydraulic jump." (A second sheet of foam in the foreground, indicating another hydraulic jump, is merely incidental). The scene is quite peaceful and harmless, the water purling gently through the jump, like a kitten at play.

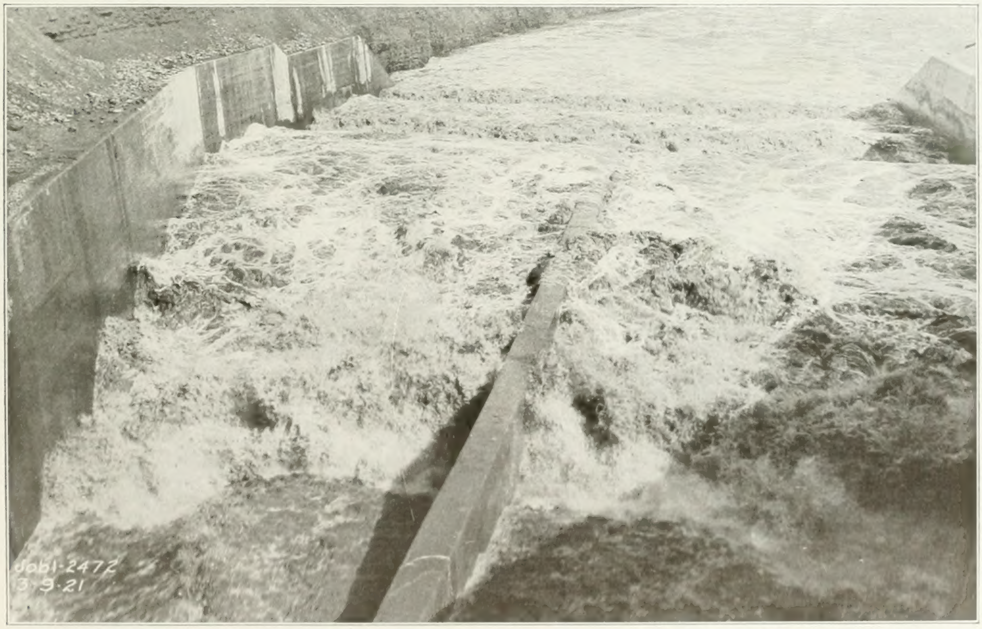
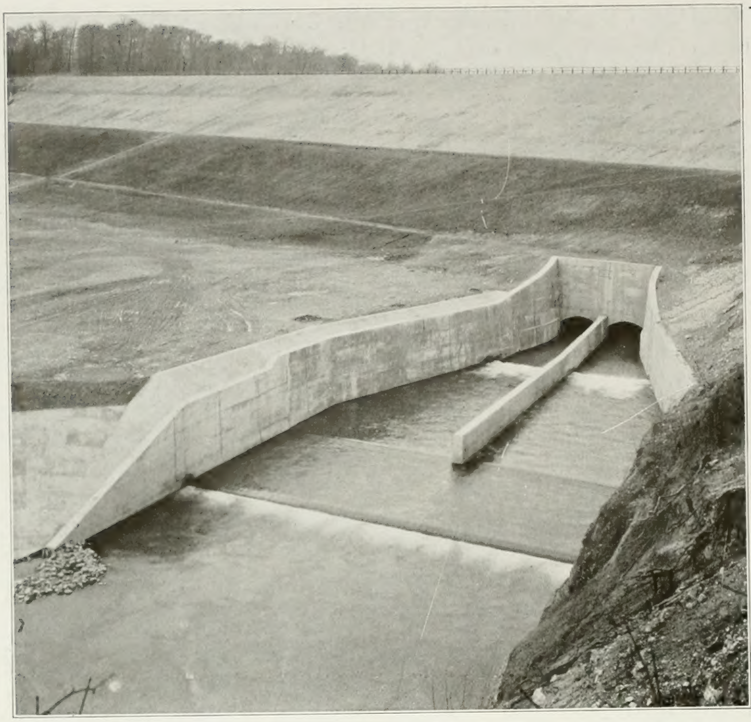


FIG. 290—GERMANTOWN CONDUIT OUTLET BASIN, FLOOD OF MARCH 9, 1921

Looking downstream from top of headwall over conduit mouth. The smooth dark water in the foreground is the rushing flow from the conduits as shown in Fig. 294. See also Figs. 287 and 292. The end of this smooth water is the beginning of the "hydraulic jump." The saw-toothed climbing of the water through the jump is shown clearly along the wall at the left as far as the angle in it. (Compare the wall top, which is level). The rise in water level was about 5½ feet. The surface water flowed back down the incline toward the observer.



Compare with the picture on the opposite page which shows the same outlets under flood discharge. See also pages 133 and 134. The conduits are here seen to be twin tunnels of concrete, carrying Twin Creek under the dam, the downstream slope of the dam embankment rising behind the conduit mouths. The water issuing from the conduits is seen to break a little below them into a narrow sheet of foam, indicating the position of the "hydraulic jump." (The nearer sheet of foam is incidental). The scene here is very peaceful and serene, the water purling gently through the "jump" like a kitten at play. Fig. 292 is a corresponding view during high water, with a flood flow through the conduits more than half that which would be produced by a storm like that of 1913. The kitten—here seen to have been a cub—is as it were half grown, "making consid-

(Continued below)

FIG. 291—CONDUIT OUTLETS, GERMANTOWN DAM, AT ORDINARY STAGE, MARCH 4, 1921

erable splash," but powerless for harm, a young lion, but with its teeth drawn. A 1913 storm will bring the beast to full growth, but the same mechanism which pulled the young lion's teeth will pull the grown one's. The mechanism has proved itself amply adequate to its full task.

Fig. 292 is a corresponding view during the high water. Fig. 290 is a close-up looking downstream from the top of the wall over the outlets. Fig. 287 is similar to Fig. 292, but from a greater distance. All show very well the conditions with a flood flow through the conduits more than half that which would be produced by a storm like that of 1913. The kitten—now seen to have been a cub—is here as it were half grown, making "considerable splash," but powerless for harm—a young lion, but with its teeth drawn. A 1913 storm will bring the beast to full growth, but the same mechanism which pulled the young lion's teeth will pull the grown one's. The mechanism has been tried, and given ample evidence of its adequacy to the full task.

The mechanism is a simple one—an adaptation of a device often seen in Nature doing a similar work. It has no moving parts to get out of order. It is built of concrete and bedded in the solid rock, as it needs must be to withstand the shock of the impact of such powerful masses of water as have been indicated. It consists in a widening and deepening of the conduits below their outlet, into a double concrete basin which opens downstream into the creek channel below the dam. Inspection of Fig. 291 will make this quite clear. Each conduit is 13 feet wide; the width of the double basin is 85 feet. The basin floor slopes down to a depth 16 feet below that of the conduits. There is thus formed in the basin a wide, deep pool of water, like the pool often seen at the foot of rapids in a brook.

The action in the pool in both cases is the same—to provide a water cushion which receives the sharp impact of the descending stream, and checks its velocity. And just as the stones in the brook act to aid the water cushion in slowing down the flow, by roughening the bottom and offering obstructions; so the concrete basin has its bottom purposely roughened, and artificial obstructions provided, to produce similar effects. The roughening is produced by building irregular steps in the descending floor, as it leads down from the conduits to the bottom of the "pool chamber." The artificial obstructions are in the shape of two submerged walls which are carried across the entire width of the outlet basin at its downstream end. The tops of both of these walls can be seen through the water in Fig. 291, the nearest foam sheet being formed by the water pouring over the crest of the lower one.

Both in the brook rapids and the conduit outlets, where the swift current strikes the slower water of the pool below, there is formed what is known as a "hydraulic jump." In the case of the brook the jump is apt to be rather imperfect. A more perfect

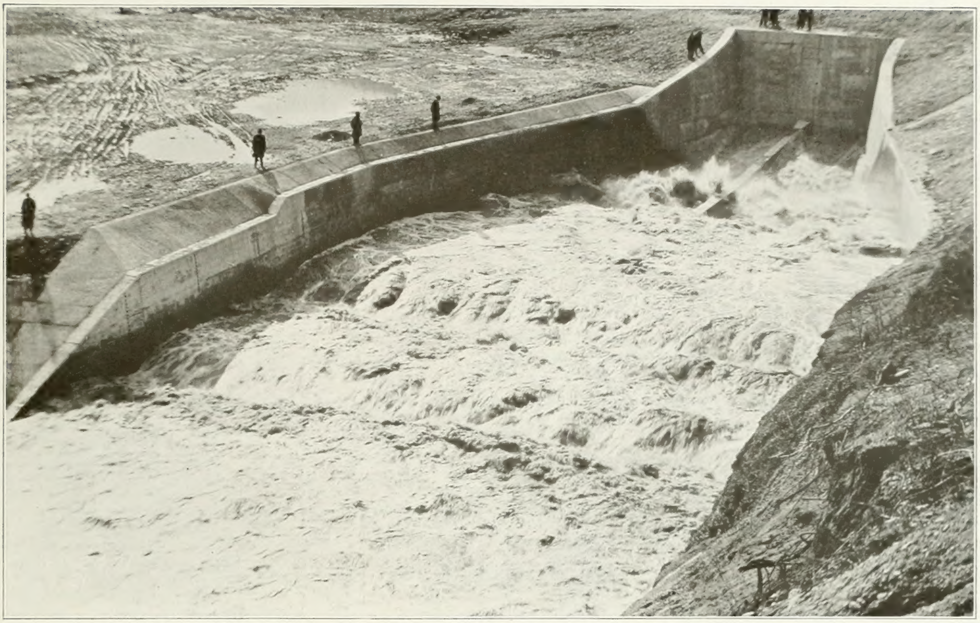


FIG. 292—OUTLET CONDUITS, GERMANTOWN DAM, FLOOD OF MARCH 9, 1921. (SEE FIG. 291.)

form may be seen where the sheet of water which slips over the level crest of a dam (as at the Steele dam in Dayton), slides on down the sloping "apron" and strikes the water of the stream below. Where it strikes, a stationary wave is formed, the sheet of water shooting into the base of this wave, and by its momentum forcing the water below to a higher level, whence it flows away downstream. Down the sloping wave front, from this higher level, the water is perpetually tumbling over backward toward the dam, breaking into foam as it tumbles, precisely in the manner of a breaking wave on a sloping sand beach. In fact, it very much resembles such a wave, except that instead of rolling onward it stands still. It is in this standing wave that the "hydraulic jump" occurs.

The name, "hydraulic jump," is an apt one as describing the appearance presented. The water does seem to jump suddenly up; but the jump is only in seeming. Actually the higher level is the effect of the plunge of the descending sheet into the base of the wave, lifting the water below as it were on its shoulders.

It is this work of lifting the water which robs the descending stream of momentum and slows it down. There is, however, a further effect, due to what may be called the boiling away of an additional fraction of the momentum into foam. The water in the jump is churned into a white lather of tiny eddying bubbles. The eddying water particles rub against each other, and against the air of the breaking bubbles, with resultant friction. And this friction acts as truly in checking the momentum of the moving water as the friction of the brake shoes on the car wheels checks the momentum of a moving railway train. The tiny brakeshoes of air and water are very small, but there are millions of them, and the sum total of their effect is as unquestionable as the sum total of the sand grains that build a sea beach.

There are thus two ways in which the hydraulic jump operates to destroy the velocity and kill the destructive energy of the water as it issues from a Conservancy dam outlet—by compelling it to lift a mass of water below, and by means of friction.

Besides these must be reckoned the effect of what may be called diluting the speed of flow, by spreading it over a deeper and wider channel than it had in the conduits. The combined effect was to reduce the velocity from 29 feet per second in the conduits to 5.5 feet in the creek below.

This result seems very good; but the actual effect in killing the destructive energy of the flood water was far greater than the figures make it appear. A railway train "side swiping" another at a crossing at a speed of 50 miles an hour, has far more than 5 times the destructive effect which it would have at a speed of 10 miles an hour. Power for destruction varies as "the square of the speed." The two speeds are as 5 to 1. The two powers for destruction are as 25 to 1. The 50-mile-an-hour train would smash things up with a power 25 times as great as the 10-mile train would have.

Applying this law (which is as solidly established by physical science as the law of gravitation) to the case of the Germantown flood of March 28, it will be seen that more than 26/27 of the destructive power possessed by the issuing water from the conduits was "killed." Less than 1/27 of it remained.

It need hardly be said that this result, which was quite in accordance with the expectations of the engineers who perfected the design of the outlet works, was highly satisfactory. Not only the engineers who designed and built them, but primarily the people of the Miami valley, for whose safety they were built, are to be congratulated on the proved efficiency of these very important features of the work.

Efficient Work of Germantown Dam in Checking Flood

Storm of March 28 Furnishes Satisfactory Demonstration of the Ability of the Dam to Hold Back Great Floods.

The storms of March 9 and March 28 were of unusual interest in showing the beneficial effect in actual operation of the flood protection works at the Germantown dam, in reducing the high water stages in Twin Creek and in the Miami River through Middletown and Hamilton, these being the two cities which this dam was especially built to serve.

The storm of March 28, the greater of the two, which backed up the water behind the dam to a height of 37 feet above the conduit floor (39 feet above the old creek), especially illustrates this. The appearance of Twin Creek valley above the dam, with the water a little below its maximum, is shown in Fig. 303. The lake formed extended about four miles up the valley, and contained 267,000,000 cubic feet of water, or 6130 "acre feet" (equivalent to 613 acres flooded ten feet deep). The appearance of the water emerging from the conduits is shown in Figs. 287 and 292. These latter pictures were taken on March 9, the date of the earlier storm, but the appearance on March 28 was very similar.

The water at maximum flood (5 p. m., March 28), standing 37 feet above the conduit floor, had a velocity through the dam conduits of 28.8 feet per second (20 miles per hour), and discharged at the outlet 5,250 cubic feet of water per second (equivalent to a mass 7 feet square and 107 feet long.)

These figures should be compared with those of a flood at Germantown equal to that of 1913, supposing one to occur. The velocity then would be 55 feet per second, a little less than twice that of March 28 of this year. The corresponding discharge from the dam conduits would be 9,300 cubic feet per second. The lake behind the dam would stand at a level about 45 feet higher than on March 28. The water storage in it would be 73,000 acre feet, 12 times that of March 28.

The figures bring out sharply the crucial fact regarding the system of flood protection adopted on the Miami valley project. The water stored behind the dam with a 1913 storm rainfall would be 12 times that stored on March 28 of this year, while the water permitted to pass into the valley below would be less than twice that of March 28. With the 1913 storm, the water level just below the dam would rise only three feet higher than it actually rose on March 28 last.

The effect of the dam on the flood stage just below the outlet on March 28, was to lower it 3.2 feet below where it would have been without the dam. With another 1913 storm the dam would lower the flood water level just below the outlet by 14 feet, as compared with the actual level of the 1913 flood. Here again the rapidly increased efficiency of the dam as a flood damper, with the heavier storm rainfalls, shows clearly.

The facts just given as regards the effect of the Germantown dam on the stage of water just above

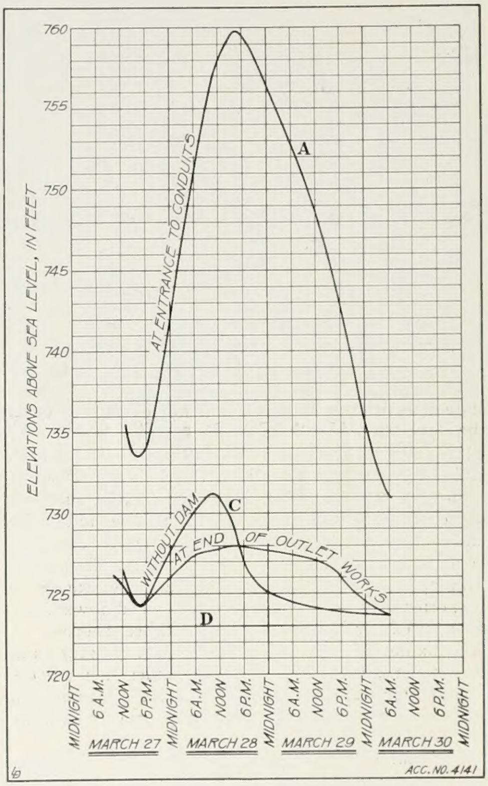


FIG. 293—DIAGRAM SHOWING FLOOD CONTROL

Platted from measures at Germantown Dam, storm of March 28, 1921. The water elevations above and below the dam are shown as they varied during four days, as indicated below the curves. Curve "A" shows the rise and fall of the water above the dam; the curve marked "At end of outlet" shows the rise and fall in the creek just below the dam; and curve "C" shows what the rise and fall would have been if no dam had been built. The horizontal lines mark elevations a foot apart, the sea level elevat ons being given at the left. The heavy horizontal line "D" marks the elevation of the conduit floors at the outlet. The curves show that the maximum elevations were reached at 5 p. m., March 28, the difference in stage above and below the dam being then 31 feet. Without a dam the maximum stage would have occurred at about 10 a. m. the same day, as shown by the curve "C." The crest of this curve shows that the effect of the dam was to lower the peak of the flood 3.2 feet.

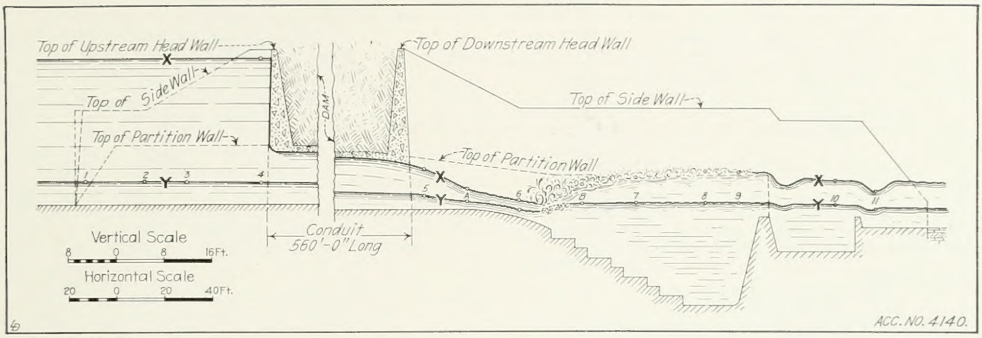


FIG. 294—DIAGRAMMATIC LONGITUDINAL SECTION, GERMANTOWN DAM CONDUITS, SHOWING HYDRAULIC JUMP

The vertical scale is here magnified 2½ times, as compared with the horizontal, to show more clearly the action of the "jump." Compare with figure below, which shows a regular section, with both scales alike. The heavy line "Y Y Y" shows the water surface at an ordinary stage, corresponding to Fig. 291. The line above it, "X X X," shows the water surface at flood stage, corresponding to Fig. 292. Water levels were read at the points marked by the small circles, 1, 2, 3, 4, 5, A, 6, etc. (The locations of these points is shown also in Fig. 295.) Both lines show that the water, (flowing toward the right) emerges from the conduit mouth (under the downstream head wall), and flows down the slope until it strikes the mass of water in the pool. Here it breaks into foam, rises in level and flows on over the two walls, (shown one on each side of the right-hand "Y"). The rise in level, accompanied as it always is by the breaking into foam, constitutes the "hydraulic jump." (See pages 133-135). It is remarkable how little change in the point of beginning of the jump occurred with the great increase in head. This stabilization, and the elimination of undesirable eddies, were very satisfactory. The velocity of the water was reduced from 29 feet per second in the conduits to 5.5 feet in the creek channel below.

and just below it, are exhibited directly to the eye in the diagram, Fig. 293. Three curves are there shown, exhibiting the rise and fall of the water at the dam from March 27 to March 30. Curve "A" shows the rise and fall just above the conduit entrance. Curve "B"* shows the rise and fall just below the outlet works. Curve "C" shows the rise and fall at the same point as Curve "B," supposing the same storm rainfall, but without the dam. The figures at the left are elevations above sea level, expressed in feet, giving a means of measuring the differences in level. The actual difference, above and below the dam, was 31.3 feet. The reduction in the flood crest by the dam, as shown by the difference between the highest points of curves "B" and "C," is 3.2 feet. The line "D" is added to show the level of the conduit floor at the conduit outlet. At the conduit inlet the floor level is one foot higher.

The rainfall which caused the high water of March 28 occurred most of it during the preceding night (March 27-8), but there had been intermittent rainfall for a number of days preceding. The quantity varied from 1.51 at Ingomar to 2.28 at Germantown dam. The total rainfall on Twin Creek watershed during the storm of March, 1913, to compare with these figures and the flood data given above, was from 9 to 11 inches.

*** Through inadvertence, the "B" meant to mark this curve has been omitted. The curve is marked "At End of Outlet Works."**

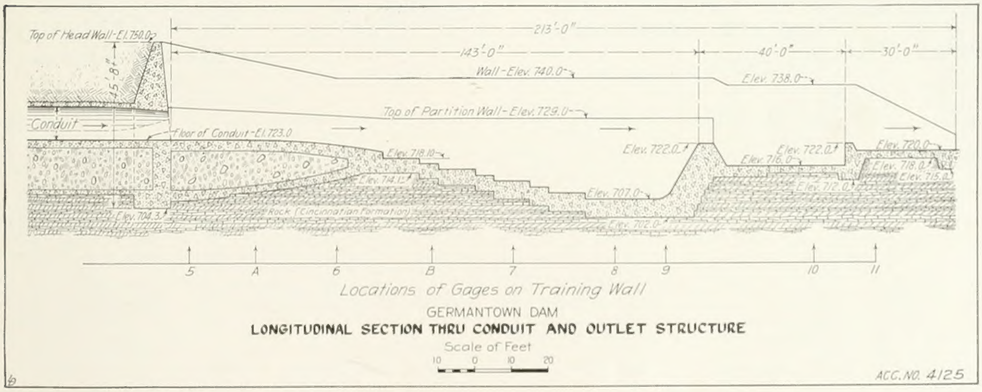


FIG. 295—LONGITUDINAL SECTION THROUGH GERMANTOWN DAM CONDUIT AND OUTLET

February Progress on the Work

GERMANTOWN

Dismantling having been completed, the work of the past month has consisted principally of cleaning up.

Some work has been done on the grading of the roadway on top of the dam, and Road No. 1, between the dam and the State Road is being re-graveled wherever repair is needed.

The clearing of old trees, brush and rubbish from the reservoir above the dam is nearly completed.

The guard rail for the roadway along the top of the dam has been straightened and a gang of men are painting it.

Planting of trees in the creek basin above the dam and of shrubs on the slopes of the dam has been started.

A. L. Pauls, Division Engineer.

March 19, 1921.

ENGLEWOOD

Embankment construction was resumed, after the winter's layoff, on March 1, using the day shift only. On March 7 the night shift was put on. From the start the output has averaged 400 cars or better per shift, with a few exceptions. This compares favorably with the best progress of last season. The date of beginning work this year is three weeks ahead of any previous season.

The large electric dragline has completed the filling of the crib at the outlet of the temporary spillway and has also completed the excavation for the permanent spillway. This machine is now engaged in leveling off the excavated material, forming with it a levee between the spillway channel and the dam.

At the permanent spillway plant has been erected for concreting. A trestle for dumping concrete aggregates has been constructed and a cement house built. The large steel derrick, which has been unloading coal at the coal pile, has been taken down and set up at the permanent spillway. The gravel screening plant has been overhauled and put in running condition preparatory to furnishing concrete aggregates.

H. S. R. McCurdy, Division Engineer.

March 15, 1921.

LOCKINGTON

Hydraulic fill operations were resumed on March 1 and good progress is being made. A 12-in. centrifugal pump has been installed to handle the circulating sluice water. This relieves, for use as a booster, the dredge pump which was used temporarily for the purpose.

Stone surfacing on the dam is nearing completion and a footing was laid during the low water of the winter for rip rapping on the west side of the outlet channel.

Work on Road 11 in the basin, about six miles above the dam, is nearing completion and the last fill on Road 9 will probably be finished during the coming month.

Preparations are being made for placing the remaining concrete of the outlet structure, and the concrete bridge over the spillway. This work will commence as soon as river conditions will warrant, which will be during the latter part of April.

Barton M. Jones, Division Engineer.

March 22, 1921.

TAYLORSVILLE

The river has been partly turned through the new outlet channel, and in about two weeks the lower end of this channel will be sufficiently widened to carry the entire flow. The old channel can then be closed as soon as the danger from spring floods is passed. All rock excavation has been finished. The estimated total rock excavation was 219,000 cubic yards, and the actual 230,600 cubic yards.

The sluicing is now running two 10-hour shifts, and is making good progress. That part of the dam from the cross dike west is now within 10 feet of the spillway elevation, or 29 feet from the top.

A contract has been let to Robert Brothers, of Chicago, to dress up the rock dumps on each toe of the dam, west of the river, to a uniform slope and berm width and use the surplus to continue these slopes and berms across the river; also to make the long Class "F" blankets in the old river channel.

Roberts Brothers started work on this contract on March 17.

O. N. Floyd, Division Engineer.

March 22, 1921.

HUFFMAN

The major operation during the past month has been the pumping of material into the embankment of the dam. The greater part of this is being excavated from the main borrow pit in the valley above the dam, and the remainder from a pit on the hillside at the north end. Work in the latter was continued on March 1, when a new pit was opened up just east of the one used during the past season. To date the quantity and quality of material found in this pit checks very closely with previous estimates. It has a high percentage of the finer elements, which added to the earth from the main borrow pit, containing an excess of gravel, makes the proper balance in the dam between fine material for core and coarser material for slopes. It is also expected that the material from this pit will boost the progress sufficiently to insure the completion of the embankment this season, as there is some question whether the one dragline in the main pit could excavate the required material alone.

On March 1 a total of 654,000 cubic yards had been placed in the dam. This is just 50 per cent of the total material required for the embankment.

The steam dragline has practically completed the excavation work in the outlet channel below the concrete works. Rock paving is being placed on the slopes of this channel where necessary.

C. C. Chambers, Division Engineer.

March 22, 1921.

DAYTON

Dragline D-16-15 has continued river excavation below Stewart Street. The 24-in. water main above Fifth Street bridge has been lowered to a new level, below channel grade, and dragline D-16-15, which performed the excavation for that work, is about to pass under the bridge. D-16-8 is beginning levee construction on the right bank of the river below the Big Four railroad bridge near Miller's Ford. D-16-19 has completed the channel excavation above Dayton View Bridge and is now cleaning up the surplus excavation from the Sunset Avenue retaining wall at Third Street bridge.

Retaining walls are under construction at Beach Avenue, First Street, First Baptist Church, Negley Place at Ferguson Avenue, Taylor Street and at the southeast wing wall of Keowee Street bridge.

The Finke Engineering Company is continuing work on the Apple Street culvert. Price Brothers Company has constructed the head wall and discharge channel for the Herman Avenue storm sewer. J. C. McCann has moved his steam shovel to Findlay Street and started levee construction on the south bank of Mad River.

To date 63,950 cubic yards of sand and gravel have been issued from the Sunrise Avenue gravel plant.

The total quantity of channel excavation (Item 9) completed up to March 1, was 918,500 cubic yards. Levee embankment amounted to 176,250. Total yardage handled was 1,995,000 cubic yards. None of the figures include 105,000 cubic yards of excess excavation for scowing canals.

C. A. Bock, Division Engineer.

March 23, 1921.

HAMILTON

Work on the west bank above the Columbia bridge has been completed and the electric dragline has crossed to the east side, where it will pass under the bridge and then proceed south to about Station 93, near Hanover Street. There it will again cross the river and begin work on a cut of 360,000 cubic yards. The material from this cut, with the exception of 90,000 cubic yards, will be hauled over the trestle at Station 110 into the spoil bank in Peck's Addition. The 90,000 cubic yards mentioned will be wasted along the west side of the cut.

Concreting of the west abutment of the Black Street bridge has been completed to a point about three feet below the sidewalk level. The abutment is being backfilled with cinders from the Champion Coated Paper Company. Concreting of pier No. 1 has been completed. The Bucyrus Class 14 dragline is at present piling up gravel for further use on the bridge and the Black-Clawson wall, after which it will drive the piling for the false work for spans 1, 2, 3 and 4.

The work of concreting has been resumed on the footing of the Black-Clawson wall.

The small Marion dragline is grading for temporary tracks on the west side of the river below Station 95.

C. H. Eiffert, Division Engineer.

March 21, 1921.

UPPER RIVER WORK

Troy—The high water during the first of the month did not affect the work of Donald Jeffrey to any great extent. The dragline (D-16-21) has continued to place the embankment for the East Levee, and to date about 20,000 cubic yards of material has been placed. The levee is nearly complete for a length of 1600 feet. After this work is finished the dragline will cross the river above the old dam and start work on the levee extending along the M. & E. Canal. This levee joins the levee, known as the South Levee, being made by the Finke Engineering Company at Morgan Ditch, and extends southeasterly to the Adams Street bridge.

The Finke Engineering Company has suspended operations until they have better weather conditions.

The contract of the C. & C. Haulage Company has been turned over to T. Daniels & Son of Dayton. Their equipment will consist of an Osgood steam shovel and teams. Only one shovel and five trucks remain of the C. & C. Haulage Company's equipment. They have about 1500 cubic yards of material to place in the levee on the right side of the river and expect to leave as soon as this work is complete. Their total excavation will amount to 80,000 cubic yards.

The high water caused considerable delay in excavating for the north abutment of Market Street bridge. It is expected to be completed in the next day or two. A formation of very fine sand or silt above the gravel is causing considerable difficulty in the work of keeping the water down and in the excavating.

The contract for building the aforesaid abutment has been let to Price Brothers Company. Three of their men have already arrived and have been helping with the pumping outfit.

Tippecanoe City—The work of erecting a pole line at Tippecanoe City has progressed favorably, and is practically completed at this time.

A. F. Griffin, Assistant Engineer.

March 20, 1921.

LOWER RIVER WORK

Miamisburg—On the fourth of March Cole Brothers commenced construction of levee on the Balon property at the southern extremity of the protected area, after a two-mile move. Since that date they have completed 1,200 linear feet of levee, containing 14,000 cubic yards of material. They have also torn up the brick pavement for the Fourth Street elevation, laid 145 feet of 24-inch sewer pipe to carry the water off this street and made most of the gravel fill.

Franklin—The dragline has made the excavation for the conduits for the tail race of the American Writing Paper Company, raised the 95 foot mast of the derrick to be used in the construction of the conduits and crossed to the north side of the tail race, where excavation for the temporary channel has been commenced. This work has been delayed considerably by high water.

Trestle construction north of the head race of the American Writing Paper Company is about 75 per cent complete. A trestle has also been built across the hydraulic canal. All the material which goes into the levee north of the paper mill will be hauled across this bridge.

Clearing of timber along the west bank of the hydraulic is progressing. About 45,000 cubic yards of material from the channel excavation will be wasted along this bank.

—**Middletown**—Price Brothers have completed the Hydraulic Street wall and are now making repairs to a portion of the wall which was injured by freezing temperature.

F. G. Blackwell, Assistant Engineer.

March 22, 1921.

RAILWAY RELOCATION

Big Four and Erie. The Big Four maintenance forces are removing the rail from the old Big Four line. They have approximately 60% of it taken up.

The District forces have completed constructing cattle pens for the Big Four at New Osborn. They have also been salvaging material from the old lines, the ties being shipped to other features of the District.

Ohio Electric Railway. The rail bonding has been completed and the railway company are now cross bonding, which will be completed within a short time.

The contractor, Joseph Connelly, completed grading the gap at Mud Run bridge, just east of Osborn, with the exception of a small portion that still remains where the Big Four tracks cross the Ohio Electric. This will be completed as soon as the Big Four tracks are torn up, which will be about the last of April.

Mr. Joseph Connelly was also awarded the contract for grading the gap at Mad River bridge which was washed out by the spring flood of 1920. This work, about 3,000 cubic yards, will be completed about April 1st.

The Brookville Bridge Company have completed the fabrication of the steel for the bridge over Mad River. This is ready for shipment to the site of the work just as soon as the track is laid to the bridge from Fairfield.

Baltimore & Ohio. Work completed.

Albert Larsen, Division Engineer.

March 25, 1921.

RIVER AND WEATHER CONDITIONS

No freshets of importance occurred in any of the streams of the Miami Valley during the month of February.

The rainfall at the District's stations varied from 1.20 inches at Pleasant Hill to 2.57 inches at the Germantown Dam. At Dayton the total amounted to 2.25 inches, or about .83 inches less than normal.

The local Weather Bureau records show that the mean temperature for the month was 35.8 degrees, or 5.2 degrees greater than normal; that there were 4 clear days, 5 partly cloudy days, 19 cloudy days, and 9 days on which the rainfall amounted to 0.01 of an inch or more; that the average wind velocity was 11.4 miles per hour, the prevailing direction being from the southwest; and that the maximum wind velocity was 39 miles per hour from the west on the 16th.

Ivan E. Houk, District Forecaster.

March 25, 1921.

Screen for Boiler Feed Water Sediment

In the early days of the "Dorothy Jean," the Conservancy river tug pictured in our last issue, the purchasing division of the District was rather amused and puzzled by receiving a requisition for marsh hay and turkish toweling, to be used in connection with the boat's steam boiler. They are old hands at their job, but marsh hay and turkish toweling for a steam boiler, were new kinds of "fodder," requiring explanation.

The two materials were in fact for use in the construction of a hay filter for the removal of sediment from the boiler feed water. The origin of the device is not known. It is not new, but does not seem to have been described, and is believed to be worth presenting. It was introduced on the Miami River job by Messrs. H. A. Hanson, Superintendent, and V. H. Tucker, "Fleet Captain" of the scow and tugboat service, who had used it successfully on the Barge Canal in New York (at Rome) on the work of Charles H. Locher there.

The mechanical construction is shown clearly in the illustration, and needs little explanation. It shows a long rectangular wooden tank, divided into compartments by cross partitions, through which the feed water is made to circulate, entering at one end and leaving at the other, passing through repeated filters of the hay and turkish toweling in the course of its journey. It enters perhaps yellow or

brown with unsettled river mud. It leaves (ready to enter the boiler), "clean enough to drink."

Five filters are shown, but the number is not arbitrary. In some cases probably fewer would be sufficient. In each the direction of flow is upward—an important consideration. The five compartments are separated by double baffle boards, the two boards in each case two or three inches apart, sufficient to leave space for the water between them, the water passing in all cases over the top of the board nearest the inlet, and under the bottom of the other, thus delivering the water always at the bottom of the next compartment. Each compartment is simply packed full of the hay, up to the level of cross cleats near the top, these cleats providing support for a finer screen made of the turkish toweling. This is made by tacking the toweling to a rectangular frame after the manner of mosquito netting.

The water in its passage—always upward, through the filter compartments—leaves sediment in the meshes of the hay and upon the under side of the toweling rather than upon the upper side. This may seem a small matter, but it means a difference between cleaning the filter twice a week, and cleaning it several times oftener; in other words, it stops the deposition and packing of a thick layer of silt on the top of the left-hand towel screen, with consequent rapid clogging of the flow.

On the Dayton job the use of this device has meant the elimination of a shutdown during the week to clean sediment from the Dorothy Jean's boiler; one boiler cleaning, during the regular week-end shutdown, being sufficient for this period.

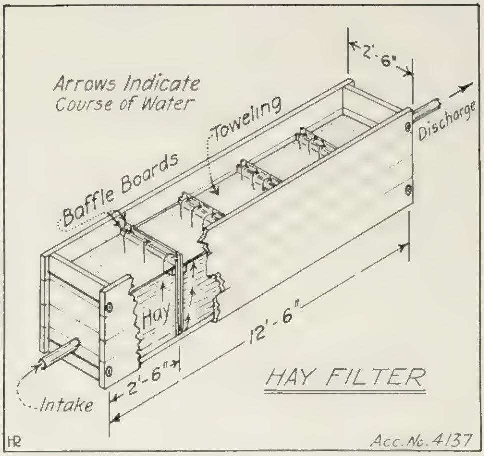


FIG. 296—HAY FILTER FOR FEED WATER

The filter was cleaned twice a week, very simply, by removing the towel screens and washing them off with a small hose, the hay not being removed, or indeed treated in any way except to remove and replace it at long intervals with clean material.

The simplicity and efficiency of the device, which can be easily built by any carpenter, makes it worth trial. It should be understood that it is for sediment only; lime or other deleterious chemical ingredients being of course untouched.

White Iron Dredge Pump Shells Again

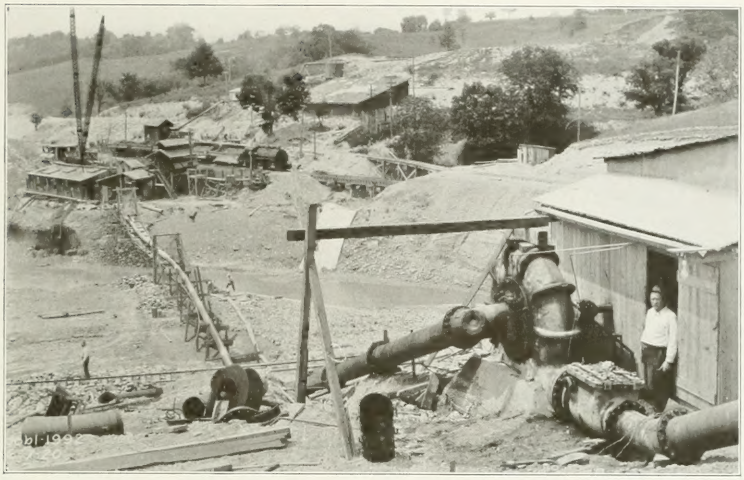
Remarkable Performance of 15-Inch Pump at Germantown, Which Was About One-third Worn Out After Pumping 380,000 Cubic Yards of Sandy Material.

In the Bulletin for June, 1920, an account was given of the building at the Conservancy shop of a new centrifugal dredge pump shell of white cast iron, and of unusual thickness, to give greater wear and thus save in cost of pumping equipment. The wear is due to the attrition of the particles of sharp sand and gravel thrown from the rapidly revolving pump runner, cutting away the metal of the interior surface of the pump shell. In the pumps first operated at the Conservancy dams (in pumping the mixed earth and water to the summit of the dam to be placed in the embankment), the shell would be worn out after handling 160,000 to 180,000 cubic yards of the earth material. It was hoped by use of the thick white iron shell to increase this duty by a large percentage.

The pump was a "15-inch pump," absorbing at maximum load 500 horse power, and capable of pumping 7,000 gallons of water per minute against 150 feet maximum head. It was set up at the Ger-

The white iron "booster" pump is at the house half way up the slope; the "primary pump" in the house at the extreme left. The pipe line carries the earth (mixed with water) up the slope to build the dam at the summit. The "primary pump" drives the material as far as the "booster;" the latter "boosts" it on to the top.

FIG. 297—PIPE LINE CLIMBING UPSTREAM SLOPE, GERMANTOWN DAM, JUNE 6, 1920.



This is the pump half way up the slope in Fig. 297. It is driven by a 350 horse power electric motor in the house. The mixed earth and water coming up the pipe at the slope are sucked in at the center of the pump shell and driven out again up the pipe at the right to the dam top. Revolving paddles within the shell do the work, whirling the material from the pump shell into the pipe at the bottom like a stone from a sling. This pump drove 380,000 wagon loads of earth to the top of the dam.

FIG. 298—WHITE IRON BOOSTER PUMP, GERMANTOWN DAM, JUNE 1, 1920

mantown dam, on March 20, 1920, on the lower berm, about fifty feet above the valley floor, to act as "booster" to the "primary pump," of similar capacity, which was in the main pump house, on the lower valley slope, 40 feet below the booster. The dam summit was 47 feet above the booster, and the "sump" or cistern which fed the primary pump suction was 7 feet below the primary pump. This layout is shown in Figs. 297 and 298, the booster being in the lower right-hand corner of Fig. 298, and the primary being in the pump house in the upper left. In Fig. 297 the booster is at the upper pump house (at the right), and the primary pump house is at the left; this figure showing plainly also the pipe line connecting the two and proceeding on to the dam summit.

The material pumped was derived from the valley bottom and the valley slope, the latter being drawn on to remedy a deficiency in clay materials which developed in the borrow pit on the valley floor. The mixed material may be roughly graded as 20 per cent clay and 80 per cent sand and gravel, the latter being deposited in the dam slopes and the former in the center core, as described in earlier numbers of the Bulletin.

The matter of the nature of the material is important. The most common application of the dredge pump is to the excavation of the soft silts deposited in harbors and similar situations where the lack of the sharper sand and gravel enables ordinary cast iron to give excellent service in resisting wear. Some of the earlier pumps installed on the Conservancy work were of this type, the necessity of rushing the work, and the exigencies of securing equipment during the press of war time, not permitting the application of rigid selection and choice. In the materials available in the Miami Valley for the Conservancy dams, however, such pumps quickly showed their inability to stand up under the hard service required. The No. 1 pump at Germantown cracked along the midline of the outer rim of the shell after pumping only 85,000 cubic yards of the valley bottom material. It was then patched with a liner inside, which carried the yardage delivered to 166,450, when the pump had to be abandoned on account of air leakage breaking down delivery of material to the suction end. The No. 2 pump cracked in a similar way after pumping 95,650 cubic yards, and was similarly treated, but in an improved manner, so that after pumping 150,800 yards it had still a good deal of available wear remaining, but was replaced for other reasons.

These facts are stated in order that the performance of the white iron pump may be the better appreciated. This pump, "No. 5," operating from March 20 to November 6, when the embankment was completed, delivered 380,000 cubic yards of materials into the dam, of which about 80 per cent, as stated, was sand and gravel. At the end of this task, the greatest wear to the pump shell was 1¾ inches. This occurred next the bottom, at the outside rim, where the original thickness was 5¼ inches, leaving thus 3½ inches of shell thickness available. That is, the shell, roughly speaking, was about one-third worn out; or, since the skin of a casting is somewhat harder than the remainder, a little more than one-third worn out.

A little more detail on this point may be interesting. Considering the face of the pump in Fig. 298 under the analogy of a clockface, at "six o'clock" the original thickness was 5¼ inches, the final 3½ inches; at eight o'clock, the original thickness was 5 inches, the final thickness 4 inches; while at 10 o'clock and 12 o'clock, where the original thickness was 4½ and 4¼ inches respectively, the wear was so little as to make its measurement uncertain, considering the irregularities of the metal surface. The concentration of the wear at the bottom and lower left quadrant is notable, and if shown by later tests to be normal, may well be taken account of in the design.

This No. 5 pump is to be set up later at the Taylorsville dam, where its subsequent performance will be watched with interest. The Conservancy

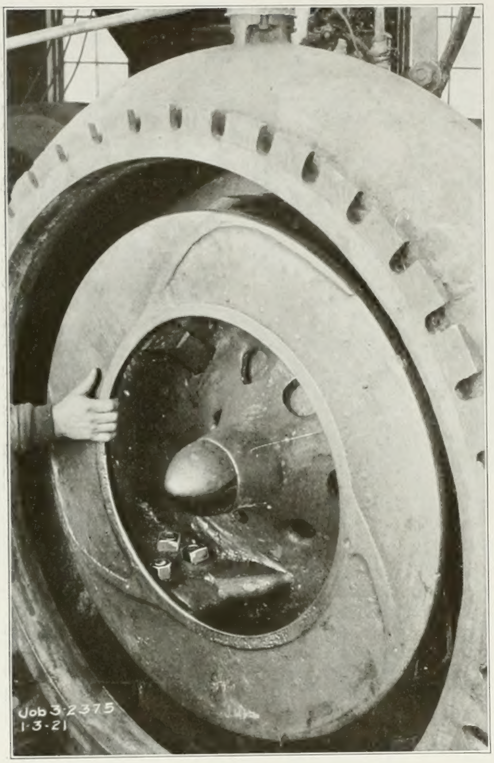


FIG. 299—PUMP RUNNER, LOCKINGTON DAM

Taken Jan. 3, 1921. The mechanism differs in detail only from the Germantown pump. The drum on which the hand is laid, with most of what can be seen within it, is the "impeller" or "runner." A flat circular plate fits close against both the runner and the outer shell, but does not cover the large central opening, through which the mixed earth and water enters the hollow interior of the runner. Three curved revolving blades throw it out again, through openings in the outer face of the runner (the latter being drum-shaped), into the hollow interior of the outer ring or "pump shell." At the same time the material receives a swift circular motion which throws it into the pipe shown at the pump bottom in Fig. 298. The curve of the three runner blades is shown on the flat face of the runner drum, and one face of one blade can be seen within the drum's interior. (The three nuts fasten a removable shoe to the blade to take the wear). The curved blade is seen to be solid at its edges with the flat face of the drum, blades and drum being cast in one piece. The projecting central boss is to direct the entering material into the hollow of the drum interior. The cobblestones in the materials (all sizes up to 6 inch diameter passing through the pump) made this an undesirable feature at the Conservancy dams, and it was removed in later designs..

engineers look for 500,000 to 600,000 cubic yards additional delivery from it, bringing the total to 900,000 or a million; perhaps more.

This pump was of very hard white iron, so hard as to make the machining of it in the lathe rather difficult. On this account, the No. 6 pump, set at work at Germantown on May 15, as a primary pump, was made of a grayer grade, and was therefore softer. This pump up to November 6 pumped 270,000 cubic yards of material, and was judged by the division engineer, Mr. Pauls, to be then about half worn out. It also will be set up later at Taylorsville, where its record will be available for further study.

In connection with what has been said, Figs. 299 and 300 will be of interest, as giving a vivid idea of the sharp-cutting, emery-like action of the Miami Valley material on pump metal. Fig. 299 shows the interior of a 12-inch dredge pump at the Lockington dam, of slightly different pattern from the white iron pumps. The conspicuous feature here is the impeller, its blades or paddles, outlined on the face of the runner, and most of one blade visible through the opening. To take the wear, removable shoes are bolted to each blade, the nuts of some of these bolts appearing on the blade seen. Fig. 300 shows what happens to the bolt heads under the sharp impact of the sand and gravel particles. The near face of the worn bolt head is ground to a knife edge over part of its length, the original thickness of the head, shown at the right, being one inch. The curious erosion of the bolt shank next the head, due to fine sand particles burrowing their way beneath, is also notable. The bolt head shown was worn to the condition presented in about one month of service, the material pumped during that time, in this particular case, being about 30,000 cubic yards. An inch scale is placed in the figure to give approximate sizes. The central projecting boss in Fig. 299 proved a bad feature when large stones (up to 6″ at Lockington) must pass the pump.

The ribs cast on the new pumps, which appear prominently in Fig. 298 are an important feature. The pump shells wear thin and fail eventually, cracking along the midline at the outside rim. The ribs prevent this cracking, and will enable the shells to wear till actual holes appear at the rim. Even then,

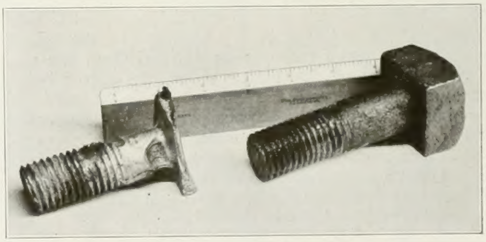


FIG. 300—PUMP RUNNER SHOE BOLTS

Taken January, 1921. There is plenty of sand and gravel in the earth material which mixed with water passes through the dredge pumps at the dams, and they are driven through at high speeds, including stones and pebbles up to six inches in diameter. These materials keep up a combination of sand blast action and rattling machine gun fire on the pump interior when the pump is in action, which makes a massive design necessary to withstand. The wear is also very severe. Holes were sand-blasted through the heavy pump shell, when made of ordinary "gray" cast iron, in a few months' time. The left hand bolt in the picture shows what one month's wear at Lockington did. The bolt head on one face is worn to a knife edge. The original thickness of this bolt head (shown at the right) was one inch. A six-inch scale is set up behind the bolts to show sizes. Note the curious wear on the bolt shank, where the sand sifted in under the bolt head.

a metal lining can be added, as was done to the first pumps quoted above, and a considerable additional yardage obtained.

Manganese steel pump shells in use at some of the dams of the District, it should be added, have also shown a high duty. Details of their performance will be presented at a later date.

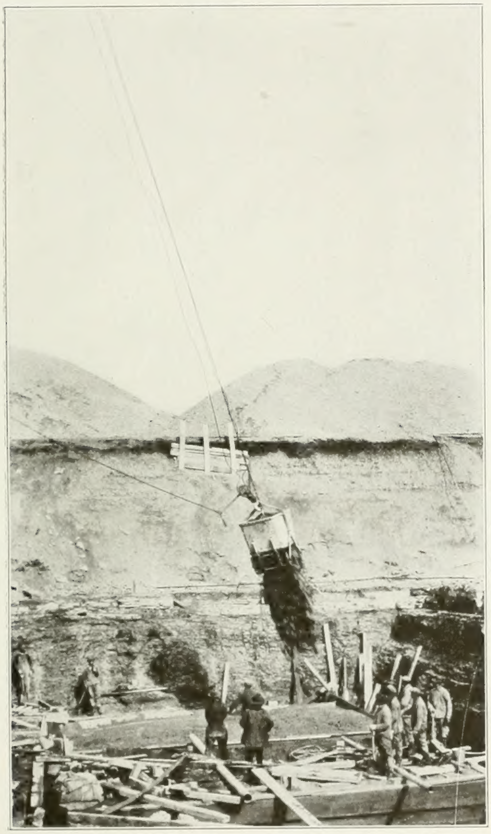


FIG. 300—"THROWING THE BUCKET" AT LOCKINGTON DAM

The picture shows what a skilful derrick artist can do in an emergency. A concrete bucket is shown in midair (the derrick boom which supports it being out of sight above), in the act of dumping its load of nearly 3 tons of mass concrete for the outlet conduit walls at the Lockington dam. The form below, into which the concrete is seen falling, was in this case too far away from the derrick to be reached by the regular procedure, and with only a comparatively few remaining yards of concrete to deposit, it did not pay to move the derrick to a new position. Hence the novel procedure shown. By hauling and slacking alternately on the boom line, keeping time to the natural pendulum motion of the bucket suspended from the boom end, the bucket was set swinging to and from the derrick foot. The load was dumped just as it reached its extreme outward swing, as shown in the picture. It was a 1⅓ cubic yard bucket—36 cubic feet, which at 150 pounds to the cubic foot, gives 5,400 pounds, or 2¾ tons, to the load of concrete. It was a "guy derrick," with 120 foot mast and 105 foot boom. The derrick artist was Mr. Ed. Hines. The work was done in the spring of 1919.

As to Finishing the Englewood Dam During the Present Season

The work at the Englewood dam, as originally planned, was to be completed at the end of the season of 1922, but the rapid progress of last year has put the schedule far ahead. The east section and the river section are now within about 42 feet of the dam summit. Pumping of earth materials into the remaining section (west of the river) began last week. By May another "sump," or pumping station, will be in operation—sump No. 4. This will be operating alone until July, bringing the west section of the dam up to the level of the other two. It is hoped to celebrate this event on the fourth of July, as it will bring the entire dam up to safety level with a 1913 flood, with the dam conduits as they now are (at double flow). Sumps 2 and 3 will then be started, with the three sumps running in rotation, each building one section of the dam, until the embankment is completed. It is hoped to bring the entire embankment to elevation 862—1913 flood level with both conduits in fully finished condition—by October, or in any case by the beginning of winter; and then during the winter to finish the conduits. This, if it can be carried out, will give complete protection from a 1913 flood by next spring. Work on the permanent spillway is already begun.

The Flood of March 28 at the Englewood Dam

Figure 302, on the outside of the back cover, shows the lake of water behind the Englewood dam during the storm of March 28, 1921. The upstream slope of the dam is in the foreground, with the entrance to the dam conduits at the left, the conduit head wall projecting a little above the slope. The Stillwater River is at the left of the flooded area, with its east bank, marked by the "marooned" row of trees, covered by the water. What looks like a pier projecting into the river from its west bank, is the construction railway trestle, with most of its length submerged. At full flood, a few hours after this picture was taken, the entire bridge was just submerged; but the water was still several feet below the conduit headwall. The maximum stage was at elevation 791, and was still 21 feet below the level of the temporary "spillway" channel. This channel is provided as a safety valve in case of a flood rising high enough to threaten the work already done at the dam, but with the flood season so nearly at an end, the likelihood of its being brought into use is very remote. The lake in the picture, it is interesting to note, shows only a little larger than it will look in its normal condition after the dam is completed, as a feature of the Englewood "Conservancy Park," referred to in an earlier issue of the Bulletin.

Only immaterial injury was done to the work at Englewood by the high water. The submerged trestle was entirely undamaged, this being perhaps in part due to the fact that the main current of the flood was "short-circuited" through the west borrow pit, thus slowing down the current in the regular river channel. The picture shows this. Electric pump motors, peculiarly liable to flood damage, were removed from the flooded area. The principal damage was to the construction tracks a little east of the submerged trestle, where the main current of the flood swept across them, but this was slight and readily repaired.

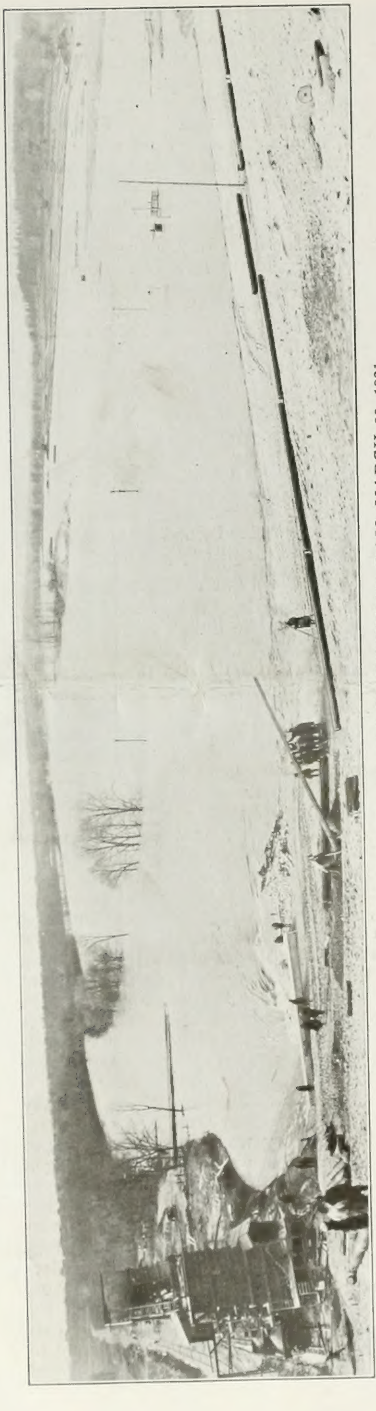


FIG. 302—FLOOD WATER ABOVE ENGLEWOOD DAM, MARCH 28, 1921.
For description see page 143

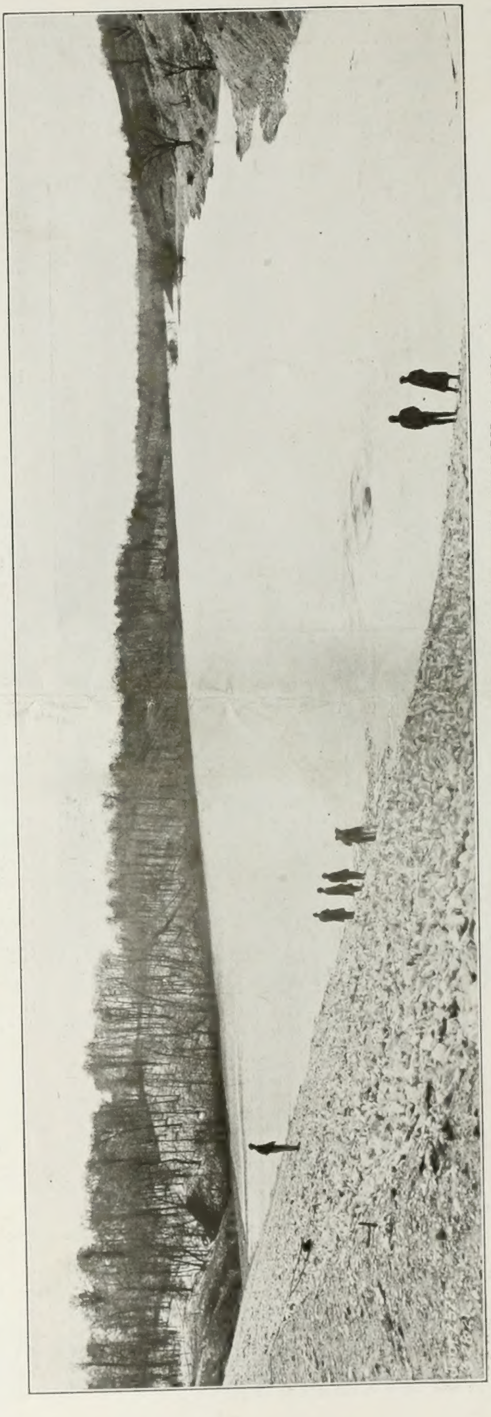


FIG. 303—FLOOD WATER ABOVE GERMANTOWN DAM, MARCH 28, 1921.
See caption of Fig. 288